ON *PETRICOLA*, *LUCINOPSIS*, AND THE FAMILY PETRICOLIDÆ.

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Contents.

1. Nomenclature and Generic Types.

Before 1853 the genus *Petricola* was included in a family which was generally known as *Lithophaga*, though the group was called Petricolidæ by d'Orbigny in 1837.[1] This family comprised *Saxicava* and *Venerupis* as well as *Petricola*. Gray was the first to restrict the Petricolidæ[2] and to separate *Saxicava* and *Venerupis* from it, and he recognized two genera, *Petricola* (Lam.) and *Naranio* (Gray). In the same year the family was adopted by Deshayes,[3] but in the second part of his Catalogue (1854) he added a third genus (*Lajonkairea*[4]), then first proposed for the shells previously known as *Venerupis decussata*, Phil., and *V. substriata*, Mont.

S. P. Woodward in his Manual of the Mollusca (1855) regarded *Petricola* as a member of the Veneridæ and not as the type of a new family, but the Messrs. Adams (1857) adopted Gray's arrangement, except that they substituted *Choristodon* (Jonas) for his *Naranio*, and did not recognize *Lajonkairia*.

From that date to the present the Petricolidæ have been generally recognized as a distinct family, the only further separation being that of a sub-genus *Petricolaria* for certain elongate species. Dr. Dall, however, regards a group of shells, separated from *Venerupis* by P. Fischer in 1887[5] under the name of *Claudiconcha*, as a section or sub-genus of *Petricola*.[6]

In the following pages I shall endeavour to show that *Lucinopsis* (Forb. & Hanl.) ought also to be included in this family Petricolidæ, notwithstanding the different shape of the shell and the habits of the animal.

With regard to *Lajonkairea* the views which different authors have taken are both curious and interesting. Searles Wood regarded the fossil form from the Coralline Crag as a species of *Lucinopsis*, assuming its inclusion in that genus without any discussion of its special characteristics.[7] Gray & Deshayes made it a genus of Petricolidæ,

[1] *Moll. rec. aux Iles Canaries* (1837), p. 109.
[2] Ann. Mag. Nat. Hist., vol. xi, p. 38, 1853.
[3] Cat. Bivalve Shells Brit. Mus., pt. i, p. 205, 1853.
[4] Deshayes spelt it *Lajonkairia*, but, being derived from M. de la Jonkaire, under international rules it should be written as *Lajonkairea*.
[5] *Manuel de Conchyliologie*, p. 1087.
[6] Trans. Wagner Free Inst. Sc., vol. iii, pt. v, p. 1057, 1900.
[7] *The Crag Mollusca*, vol. ii, p. 148: Pal. Soc., 1853.

as we have seen (in 1854). Fischer in 1887 placed it as a sub-genus of *Lucinopsis*, but retained that genus in the Veneridæ.

On the other hand, Dr. Dall in 1900 separated it from *Lucinopsis*, and gave the name as one of the synonyms of *Petricola*, remarking that "*Lajonkairea* of Deshayes is close to *Rupellaria*, differing chiefly by more regular striation, absence of strong concentric structure, and rounded rather than pyriform outline". It seems curious that neither Dall nor anyone else should have considered the possibility that *Lucinopsis* might also belong to the Petricolidæ.

Determination of Types.—The type of *Petricola* has been incorrectly given as *P. lithophaga*, because this was the first species cited by Lamarck in 1801;[1] but Dr. Dall has pointed out that Lamarck cited two species, and consequently did not fix the type; further, that in 1802 Fleuriau de Bellevue separated the first species under the name of *Rupellaria*. It is clear, therefore, that Lamarck's second species, the *Venus lapicida* of Chemnitz, is left to form the type of his genus *Petricola*. As this was also the type of Gray's *Naranio*, that name consequently becomes a synonym of *Petricola*.

The type of *Choristodon* (Jonas, 1844) is *Ch. typicum*, Jonas, and, in Dr. Dall's opinion, the characters on which it was based are merely pathological. The left anterior and the right posterior teeth are generally separated from their bases by a layer of cartilage, but Dr. Dall thinks this is due to fracture consequent on the teeth having a narrow base. He has found from an examination of a series of specimens that sometimes the teeth are only cracked, and that occasionally they are perfect. In all other respects the shell is similar to that of *P. lithophaga*, and therefore I agree with Dr. Dall that *Choristodon* must rank as a synonym of the *Rupellaria* section of *Petricola*.

The type *Lajonkairea* is the *Venerupis Lajonkairii* of Payraudeau (1826), which Philippi afterwards described as *V. decussata* (1836). When Deshayes instituted the genus *Lajonkairea* he thought himself at liberty to adopt Philippi's specific name instead of duplicating the generic appellation, but this is not allowed by the rules of the Zoological Congress.

The type of *Petricolaria* is *P. pholadiformis*, Lam. This was proposed by Stoliczka for some elongated forms of *Petricola*, which burrow in sand or peat, and have generally a full complement of teeth, three in the left valve and two in the right.

With regard to *Lucinopsis*, there is no doubt as to the type, which is the *Venus undata* of Pennant, but there is much difference of opinion as to the generic name which this type should connote. The facts are as follows. By the earlier conchologists, except Leach, the *V. undata*, Pen., was referred either to *Venus* or *Lucina*, and the name *Lucinopsis* was not given to it till 1853.[2] Long before this, however, between the years 1816 and 1818, Dr. W. E. Leach appears to have written out a list of British Mollusca, and to have separated some of

[1] *Syst. des An. sans Vert.*, p. 121.
[2] By Forbes & Hanley, *British Mollusca*, vol. i, p. 433.

them as new genera, giving names to these groups in his MS. He was evidently in communication with Lamarck while the latter was preparing his *Histoire des Animaux sans Vertèbres*, for Lamarck refers to him in many places, and acknowledges the receipt of many specimens from him.

Lamarck's fifth volume of the *Histoire*, containing the list of Conchifera, was published in 1818, and he quotes some of Leach's manuscript generic names in the synonymy of his species, but without adopting them. Thus under his *Amphidesma tenuis* he quotes "*Abra tenuis*, Leach" as a synonym, and under *Lucina undata* (p. 543) he mentions "*Mysia undata*, Leach".

There is, of course, no reference to description or figure after Leach's names, because none had been published by Leach. It is probable that Lamarck quoted Leach's names because he knew that Leach intended to publish them. As a matter of fact they were not published in Leach's lifetime, though J. E. Gray states that part of the MS. was in print in the year 1820. Many years afterwards it came into Gray's hands, and he prepared it for publication by Van Voorst in 1852, under the title of *A Synopsis of the Mollusca of Great Britain*. In this work no such genus as *Mysia* is mentioned, but on p. 313 a genus *Glocomene* is described with one species, *G. Montaguana*, of which *Tellina rotundata* (Mont.) and *T. undata* (Pult.) are given as synonyms; and there can be no doubt that the *T. undata* of Pulteney was the *Venus undata* of Pennant. Thus it is evident that Leach regarded these two species as identical, but that he had abandoned the name of *Mysia* which he had given to Lamarck.

In the meantime, however, T. Brown [1] had used the name *Mysia* in 1827. It is clear that Brown had access to Leach's original MS., for he quotes it by pages many times, and he adopted some of Leach's names. Among others he adopted *Mysia*, with *Tellina rotundata* (Mont.) as the sole representative of the genus, for though he was quite aware that Leach had regarded the *Venus undata* as a *Mysia*, he chose afterwards to follow Lamarck in placing it under *Lucina*.

From the above account it will be seen that Brown was the first to establish the genus *Mysia* on a proper basis, adopting it as his own, and figuring the shell. In my opinion a generic name ought not to be regarded as established by the mere printing of a manuscript name in the work of another author, either in the synonymy of a particular species, or elsewhere. It is to be hoped that the International Commission on Zoological Nomenclature will reconsider their decision on this point; meantime I am glad to be able to state that Dr. F. A. Bather and Mr. Oldfield Thomas agree with the view which I have expressed.

Assuming that this view will be confirmed, I adopt *Lucinopsis* as the proper generic name of *Venus undata* (Pen.); and I may here remark that the name *Mysia* will drop out of conchological literature, because with slightly different spelling (*Mysea*) it was used in 1820

[1] *Illustrations of the Recent Conch. of Gt. Britain*, pl. xvi, fig. 11.

by Billborg for an insect, so that the well-known name *Diplodonta* can be retained for *Tellina rotundata* and its allies.

With regard to *Claudiconcha*, the only species actually mentioned by Fischer in his *Manuel* is *Venerupis monstrosa* (Chem.), which consequently must be taken as the type. I shall also have occasion to discuss the *Veneritapes* of Cossmann, founded in 1886 on the *Venus Bervillei* of Deshayes.

Cooperella is another shell which may have to be included in the Petricolidæ, and the type of this is *C. diaphana*, Carp. According to Dr. Dall,[1] who has examined the types, Carpenter [2] originally described two varieties of the same species as distinct sections or sub-genera, calling one *Ædalia* and the other *Cooperella*, and regarding the former as the generic type; but as the name *Ædalia* is preoccupied, that of *Cooperella* must stand for the genus. The supposed differences consist only in the degree to which the resilium is sunk, and in the bifidity of the teeth, the extent of which varies in different individuals.

At present only one species of *Cooperella* is known, and that is a common shell on the Californian coast, but Dr. Dall has described a species from the Miocene of Virginia, so that formerly it inhabited the Atlantic Ocean as well as the Pacific.

2. Description of Shells.

Petricola and *Rupellaria*.—A general description applicable to both of these may be given, because both are boring molluscs and clearly belong to the same genus.

In consequence of the boring habit the external shape and sculpture of the shell varies much in different species; but excluding *Petricolaria*, they are either oval or pyriform; there is no lunule nor escutcheon; the ligament is external but generally sunk between the hinge-plates. The internal characters are more definite, though from the descriptions given by different authors it might be thought that they were not. Thus Gray could find only two teeth in each valve; Woodward says "hinge with three teeth in each valve", a statement which is difficult to explain; the Messrs. Adams follow Gray in making two teeth in each valve, "one of which is often obsolete," and Fischer describes the hinge as "carrying two divergent cardinal teeth in each valve, the posterior right and the anterior left being bifid", but he adds "sometimes a rudiment of a third tooth".

The real fact is that the normal number of teeth is three in the left valve and two in the right, and Dr. Dall has rightly recognized this as the true dentition of the genus.[3] There is a tendency for the teeth to become irregular and obsolete, as is so often the case in boring Mollusca, so that the number varies in different individuals and in different species. In such circumstances young shells should be examined, and the species which exhibit the larger number and most regular arrangement of teeth should be regarded as representing the normal dentition.

[1] Trans. Wagner Free Inst. Sc., vol. iii, pt. v, p. 1062, 1900.
[2] Rep. Brit. Assoc. for 1863, pp. 611, 639.
[3] Trans. Wagner Free Inst. Sc., vol. iii, pt. v, p. 1056, 1900.

Among the species which I have examined some individuals of the following possess three teeth in the left valve:—

P. bipartita, Desh.	*P. robusta*, Sowb.
P. typica, Chem.	*P. Hemprichi*, Issel.
P. lapicida, Chem.	*P. æquistriata*, Sowb.

In these species the posterior tooth is long, narrow, and parallel to the nymph which supports the sunken ligament, the median is broad and bifid, while the anterior is small with a tendency to disappear in old shells; but all agree in having a peculiar character which does not seem to have been hitherto noticed, this is that the hinge-plate is deeply notched on each side of the median tooth.

In the right valve the usual number of teeth is two, though sometimes (as in *P. lithophaga*) one of these is obsolete, and the complete dentition is reduced to 2–1. The two teeth which are generally present are the posterior and the median, and when only one remains it is the median which survives.

In genera which have three teeth in both valves as in *Chione*, *Tapes*, and *Venerupis*, if attention be paid to the manner in which the teeth interlock, it will be seen that the teeth of the right valve pass in front of those of the left valve, so that the anterior of the right occupies a more forward position than that of the left. The consequence is that if the hinge-area is laterally contracted the right anterior tooth is pushed towards the shell-margin, and tends to become obsolete. In the same way the left posterior cardinal may become merged in the ligamental plate.

This is what has happened in the case of *Petricola*; the right anterior cardinal has become obsolete, and the dental formula of the normal shell is as follows: $\frac{\text{L. } 0 \mid 1.2.3 \mid 0}{\text{R. } 0 \mid 0.2.3 \mid 0}$

Further, in some species the posterior teeth of both valves have become obsolete, leaving only a right median to fit between the left anterior and median.

As to other internal characters, it need only be said that the pallial sinus is deep, broadly rounded, and generally ascending, but in some of the *Rupellaria* section it is nearly horizontal.

Petricolaria.—The shells of this group have a similar hinge, but the hinge-plate is so narrow and so deeply notched between the teeth that practically it does not exist, and the teeth seem to spring from the shell-margin. In the right valve the plate is rather broader, and is generally thickened to support the median tooth. There are three narrow teeth in the left valve, the median being only grooved in front, not bifid; in the right valve there are normally two teeth, a broad bifid posterior, and a tall projecting median; no anterior tooth.

The pallial sinus is very deep, often reaching to the middle of the shell, but is nearly horizontal.

Most of the shells belonging to this group are very inequilateral and more or less pholadiform, the umbones being near the anterior end and the posterior region being much elongated; but *P. æquistriata* from Japan is subequilateral and of an elongate-oval shape, and

equally inflated at each end; in fact, it differs in shape from any other species either of *Petricolaria* or *Rupellaria*, and its hinge is more regular with the teeth more divergent.

Lajonkairea.—The shells of *L. Lajonkairea* and *L. substriata* also differ in shape from any of the *Petricola* and *Rupellaria* group, being short and subquadrate, the posterior portion being higher than the anterior, while the reverse is the case in *Petricola*. The hinge, however, is of similar construction, having three teeth in the left valve, the median being widely bifid, and only two in the right valve; but the teeth are more widely divergent than in *Petricola*. The ligament is well developed, but is sunk between the valves so as to be hardly visible from outside. The pallial sinus is large, broad, and ascending. The margins of the valves are smooth in spite of the strong external radial riblets.

Thus there is no doubt that, judging from the shell alone, Gray was right in placing *Lajonkairea* in the Petricolidæ. At the same time Wood & Fischer were equally justified in considering it as closely allied to *Lucinopsis*, and therefore I cannot agree with Dr. Dall in regarding it merely as a *Rupellaria*, and not worthy of separation from *Petricola*.

Moreover, Mons. A. Dollfus assures me that *Lajonkairea* is not a boring mollusc. It generally lives in sand or other soft material, and its shell is then quite regular, but sometimes it harbours in the borings of other molluscs, and then its shell becomes more or less irregular and deformed.

Lucinopsis.—The type of this genus has a thin suborbicular shell, nearly smooth, and only marked by concentric lines of growth. The posterior part is higher and larger than the anterior part. The ligament is externally very long and clearly visible from the outside, being only slightly sunk between the valves. There is no lunule nor escutcheon.

Inside there is a fairly broad hinge-plate bearing in the left valve three close-set but divergent teeth, the central one of which is deeply and broadly bifid; in the right valve there are two divergent teeth which are respectively posterior and central, and sometimes the rudiment of an anterior cardinal can be seen in front of the latter. The pallial sinus is large, deep, and ascending, but rounded at the end.

From the above description it will be seen that the internal characters of *Lucinopsis* are substantially those of *Petricola* and *Lajonkairea*; but the great difference in the shape and texture of the shell seems hitherto to have prevented conchologists from perceiving its real affinities. It is surprising that Fischer, having gone so far as to group *Lajonkairea* as a sub-genus of *Lucinopsis*, did not realize that both of them were more akin to *Petricola* than to *Venerupis* or *Clementia*.

Veneritapes.—It has recently come to my knowledge that the little Eocene shell, described by M. Cossmann in 1886[1] as the type of a new genus under the name of *Veneritapes*, is closely allied to *Lucinopsis*.

[1] Ann. Soc. Roy. Malac. Belge, vol. xxi, p. 104.

I had suspected this to be the case in 1908 from an inspection of M. Cossmann's figure, but did not feel justified in saying so because I had not then been able to examine any specimens. Early in the present year M. Cossmann was kind enough to send me excellent specimens of both valves of this rare and delicate shell, asking me at the same time to give him my opinion of its affinities.

On examining them I found that the hinge closely resembles that of *Lucinopsis*, having three cardinal teeth in the left valve, the posterior one long and narrow, the median triangular and bifid, and the anterior short, prominent, and parallel to the anterior face of the median so that the teeth are divergent. In the right valve there are only posterior and median teeth, the anterior being absent, and the front part of the hinge-plate is concave as in *Lucinopsis* and in *Clementia*. The hinge, in fact, only differs from that of *Lucinopsis* in being more oblique owing to the shape of the shell.

The shell is small, thin, quite smooth and elongate-oval in shape, like so many species of *Tapes*. There is no lunule nor escutcheon, and the ligament appears to have been short and entirely external. The pallial sinus is small and shallow, the pallial line being merely bent inwards posteriorly, so that the siphons of the animal must have been short. On the whole, therefore, though closely allied to *Lucinopsis*, it must be regarded as sufficiently distinct from the type to be considered as a sub-genus, if not a separate genus.

Cyclinella.—So far as I can learn only one species of true *Lucinopsis* is known, the *L. undata* which inhabits the seas of Western Europe, ranging from Norway to the shores of Morocco, and from the Straits of Gibraltar eastward to Italy. The American species which some authors had referred to *Lucinopsis*, and others to *Cyclina*, were separated by Dr. Dall in 1902[1] under the name of *Cyclinella*, because they had three teeth in each valve.

The type of *Cyclinella* is *C. tenuis* (Récluz), and though in shape it greatly resembles *Lucinopsis*, it has a stouter shell and a circumscribed, though not impressed, lunule. In the left valve the median tooth is thick, but not bifid, and the posterior is curved not straight as in *Lucinopsis*. In the right valve there are also three teeth, the posterior long, curved, and bifid, the median thick and triangular, the anterior small, narrow, and straight. The pallial sinus is deep and ascending, but narrow, and bluntly pointed, so that it differs much from the broad and rounded sinus of *Lucinopsis*.

In all respects both internal and external *Cyclinella* resembles *Cyclina* much more closely than it does *Lucinopsis*, the only important difference being the radial structure of the shell in *Cyclina*, which, though feebly marked outside, is strong enough to crenulate the inner margin of the shell.

On the whole my opinion is that *Cyclinella tenuis* belongs to the Veneridæ, and I shall be surprised if the animal, when properly examined from fresh specimens, does not confirm this view. Dr. Dall himself regarded it as forming a separate genus from *Lucinopsis*, and

[1] The *Nautilus*, vol. xvi, p. 44.

on this point I quite agree; but whether it should be generically separated from *Cyclina* only a comparison of the animals can decide. At any rate I shall not include *Cyclinella* in the Petricolidæ.

Claudiconcha.—The species referred to this group had always been referred to *Venerupis*, and Fischer in his *Manuel de Conchyliologie* (1887) only separated them as a section of that genus, giving *V. monstrosa* (Chem.) as a single example, which therefore may be taken as the type. Dr. Dall, however, regards them as a section of *Petricola*, remarking, "Lastly we have boring species in which the natural inequality of the valves is exaggerated and the margin of the right valve in full-grown specimens is irregularly expanded, overlapping that of the left valve which remains normal, and frequently forming channels in which the siphons lay or may be extended. For these forms, erroneously referred to *Venerupis*, Fischer has proposed the subgeneric name of *Claudiconcha*."

Dr. Dall does not explain why these species should not be referred to *Venerupis*, but he asserts them to be boring shells, whereas *Venerupis* is not. He says nothing about the animal, nor does either he or Fischer mention any other species beside *V. monstrosa*. If he had evidence that this species was a borer, he should have stated it, for the expansion and upturning of the posterior portion of the right valve is very difficult to reconcile with the idea that the animal made the hole in which it is found; on the contrary it is just the sort of deformation that one would expect in a nestler like *Venerupis*.

On application to Messrs. Sowerby & Fulton they supplied me with a specimen of *Cl. monstrosa*, and specimens of two other species which they supposed to belong to *Claudiconcha*. These were *V. madreporaria* and *V. Cumingi* (Desh.). The last mentioned is, however, unquestionably a *Venerupis*, having three distinct teeth in the right valve as well as the left.

C. monstrosa has in the left valve three teeth, small nearly equal teeth, smooth and pustular, not bifid, and much more resembling those of *Venerupis* than those of *Petricola*. The right valve has only two teeth in the adult, but this may be the result of deformation and compression, for I have specimens of *V. irus*, both young and old, in which the anterior tooth is obsolete, so that the number of teeth is then the same as in *C. monstrosa*.

In *V. madreporaria* the dentition is like that of *C. monstrosa*, except that the left median is broad and is bifid in young shells. In size and variability of shape this species resembles *V. irus*.

So far as I can judge from these few specimens it seems very doubtful whether *Claudiconcha* should be transferred from *Venerupis* to *Petricola*.

The *Cooperella* of Carpenter probably does belong to the Petricolidæ, but is certainly rather more abnormal than *Lucinopsis*, which it resembles in certain respects.

The shell is small, about half an inch long, very thin, nearly smooth, but concentrically undulated, and feebly striated; nearly equilateral, without lunule or escutcheon. There is a short narrow external ligament, which is continuous with a posterior resilium, sunk and

supported by a shelly plate behind the teeth. The hinge-plate is narrow, delicate, and excavated, bearing three teeth in the left valve and two in the right. The teeth are all narrow, prominent, and near together, hardly divergent; the left central and posterior being grooved, but not exactly bifid in any I have seen. The pallial line has a long deep sinus.

Dr. Dall created a separate family for this genus in the memoir above cited, but gave no reason for so doing, leaving us to suppose that he regarded the presence of a semi-internal resilium and very thin shell as characters of family importance. For such separation I see no necessity, though I agree with him as to the close affinity of *Cooperella* with the Petricolidæ.

3. Description of Animals.

Petricola.—I cannot find that anyone has yet described the animal of the small typical section of *Petricola*, which was called *Naranio* by Gray. Writing in 1853 he says of it "animal ignotum"; but probably it resembles that of the *Rupellaria* section.

Rupellaria.—The descriptions of the animal of *Petricola* given by S. P. Woodward and the Messrs. Adams doubtless refer to the Mediterranean species *P. lithophaga*. They say the mantle is closed in front, thickened and recurved over the edges of the shell; the siphons are separate for the greater part of their length; the foot is small, compressed, and lanceolate, with a byssal groove on the lower margin.

These characters are evidently correlated with the boring habit of the animal; the foot being small, because there is small use for it in the limited space within which the animal lives.

Petricolaria.—The animal of this group is similar to that of *Rupellaria*, but is, of course, much elongated posteriorly. The foot, however, is much larger, a fact which seems to indicate that the animal has freer movement within its soft-walled burrow, and uses its foot as a fulcrum. The siphons are separate, divergent, and remarkably long.

Lajonkairea.—The only description which I have been able to find of this animal is that given by Deshayes in Latin,[1] of which the following is a translation:—"Mantle entire, open in front, closed below and behind; siphons two, united to one another, somewhat compressed, subequal, the branchial siphon larger, and ciliated at the orifice. Foot small, compressed, linguiform. Labial appendages long, narrow, pointed, and triangular."

Lucinopsis.—As no very complete description of the animal of this genus has been published, I give the following from observation of Torbay specimens:—Animal suborbicular, mantle closed, except for a small foot-opening, margins smooth. The foot is small, laterally compressed, and broadly attached to the body; it does not show any byssal groove. The siphons are very long, entirely separate, divergent,

[1] Cat. Bivalve Shells in Brit. Mus., pt. ii, p. 217, 1854.

and the orifices of both are fringed with small tentacles. Labial appendages rather small, triangular.

Comparing the above description with that of *Lajonkairea* it will be seen that while the animals agree in the characters of mantle and foot, they differ entirely in the siphons, which are free in the one and united in the other.

Cooperella.—The animal of this has been described by Dr. Dall in the following terms:—"Siphons long, slender, separate, the branchial fringed at its orifice; mantle margins simple, free for about half the length of the shell; gills rather small, free, with direct and reflected inner and outer laminæ; palpi very small; foot compressed quadrate, without any byssal groove or obvious gland."

It will be seen that the animal, like the shell, has considerable resemblance to *Lucinopsis*, but that the mantle is much more widely open in front.

Claudiconcha.—I have not been able to find any special description of the animal of *Venerupis montrosa*, and until its characters and habits are known, especially whether it is really a rock-borer or not, its generic affinities cannot be determined.

4. Conclusions.

Reviewing the preceding descriptions and observations, I conclude that the genus *Petricola* should be restricted to what may be called the two typical sections, i.e. the *Naranio* of Gray and the *Rupellaria* of Bellevue, with *Petricolaria* as a sub-genus.

In this genus we have a group of boring molluscs, and consequently both animal and shell have been modified in accordance with this habit. I have no doubt that the original stock from which *Petricola* sprang was a form which merely burrowed in firm sand or stiff mud, in the same manner as *Lajonkairea* does at the present day. When for greater security the ancestral form took to excavating harder material, the frontal portion of the mantle would be developed to a greater extent, and the enlargement of the anterior portion of the shell may be correlated with the enlargement of the mantle tissue.

Lajonkairea seems to stand by itself. It is not a boring mollusc, and its usual habitat is believed to be hard sand, but sometimes it harbours in the rock-burrows of other molluscs, just as *Venerupis* does. It differs much from *Petricola* both in shell and in animal. The siphons are united to their ends instead of being largely separate as in *Petricola*; while the shell has a fuller and higher posterior than anterior development, and the hinge has more divergent teeth in spite of the fact that the shell is shorter. In view of these differences I think it should form a distinct genus, separate both from *Petricola* and *Lucinopsis*.

With regard to *Lucinopsis* we have seen that its internal characters, and especially the hinge, agree closely with those of *Petricola*. Its external shape is, of course, very different, but in this respect it may be compared with *Dosinia*, *Cyclina*, and *Cyclinella*, which are all free shells, burrowing in sand, while other members of the Veneridæ are elongate-oval in shape.

Though *Lucinopsis* is closely related to *Lajonkairea*, the separated siphons, their great length, and the correspondingly long ascending pallial sinus seem to prevent its being placed in the same genus. The shell, too, is thinner, and there is an entire absence of radial structure and of external sculpture.

With *Lucinopsis*, and as a sub-genus, I would place the *Veneritapes* of Cossmann for the reasons already given. With regard to *Cooperella* it seems to me to come very near these two forms, and as the internal resilium is very variable in its development, so that it is sometimes merely an extension of the ligament, the differences in the shell are small. The mantle of the animal is much more widely open than in the case of *Lucinopsis*, and some observers may regard this as a generic character. Dr. Dall is evidently of this opinion, and in deference to it I retain *Cooperella* as a genus.

Cyclinella and *Claudiconcha* I provisionally exclude from the family because there is not yet sufficient evidence for removing the one from *Cyclina* and the other from *Venerupis*. The Petricolidæ may therefore be regarded as consisting of the following generic and sub-generic groups:—

Genera.		Sub-genera.
Petricola, *Lajonkairea*.	with	*Petricolaria*.
Lucinopsis, *Cooperella*.	with	*Veneritapes*.